National Aeronautics and Space Administration

Commercial Orbital Transportation Services (COTS) Program Management

NAC Human Exploration and Operations Committee

January 13, 2015

Alan Lindenmoyer
Program Manager

COMMERCIAL ORBITAL TRANSPORTATION SERVICES

Agenda

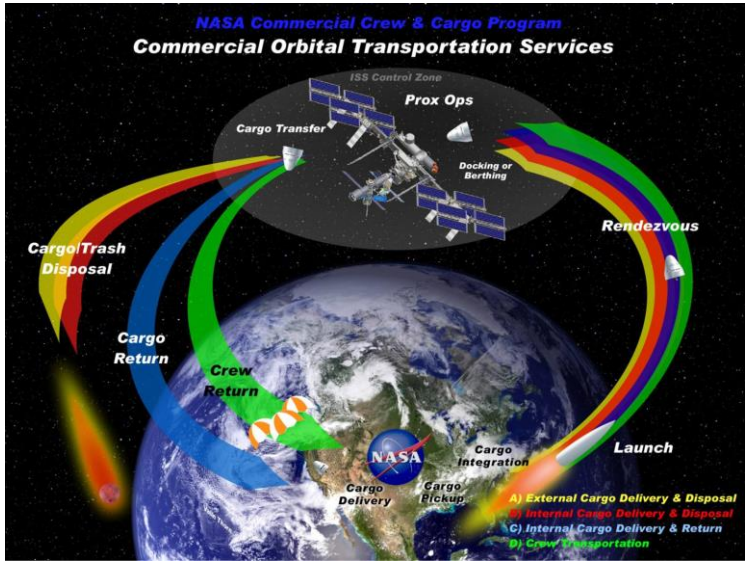
- **Purpose**
  - **Describe COTS program management approach in lieu of traditional NASA requirements**
- **Program Management**
  - **Formulation**
  - **Goals and Objectives**
  - **Execution**

Program Formulation

- **Challenge**
  - **U.S. Space Exploration Policy of 2004 called for NASA to retire the Space Shuttle in 2010 and extend human presence across the solar system, starting with a human return to the Moon**
  - **Shuttle retirement created a gap in the ability to meet U.S. obligations to service the ISS with crew and supplies prior to the availability of the new Ares and Orion launch vehicles and spacecraft**
  - **NASA challenged U.S. industry to develop cargo and crew transportation capabilities to meet these obligations and open new markets in low-Earth orbit**
- **Approach**
  - **Facilitate development and demonstration of commercial space transportation capabilities**
    - Non-traditional partnerships using NASA's *other transactions* authority instead of FAR contracts since there was no initial acquisition of goods or services
    - Cargo first, then crew
  - **Follow with purchase of space transportation *services* under FAR Part 12 Acquisition of Commercial Items**
    - ISS Commercial Resupply Services cargo contracts awarded to SpaceX and Orbital Sciences in December 2010

Program Goals and Objectives

- **The Commercial Crew & Cargo Program Office (C3PO) was established at the Johnson Space Center in November 2005 to accomplish the following goals and objectives:**
  - **Implement U.S. Space Exploration policy with investments to stimulate the commercial space industry**
  - **Facilitate U.S. private industry demonstration of cargo and crew space transportation capabilities with the goal of achieving safe, reliable, cost effective access to low-Earth orbit**
  - **Create a market environment where commercial space transportation services are available to Government and other customers**



Extending human presence in space by enabling an expanding and robust U.S. commercial space transportation industry

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Program Formulation (Cont.)

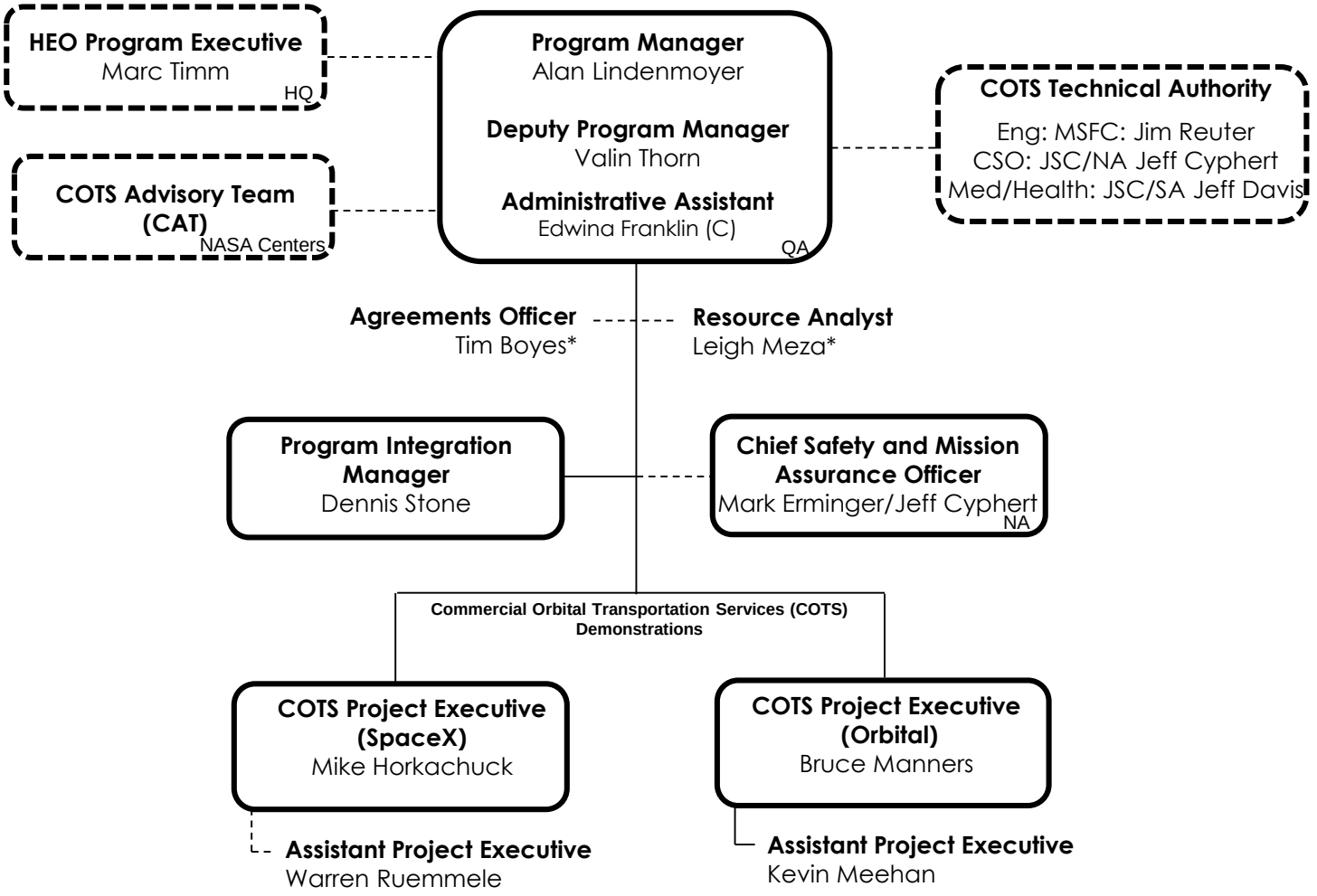
- **Strategy**
  - **Use competitively awarded Space Act Agreements to offer seed money and technical support to industry partners**
  - **$500M fixed budget over five years**
    - Multiple partners – shared cost and risk
    - Use goals vs. requirements to allow partners to innovate and optimize design
    - Firm requirements for ISS integration and safety
    - Budget was augmented in FY2011 with $288M additional funding applied to risk reduction milestones
  - **Minimize program management and administration expenses in order to maximize financial resources to commercial partners, the largest barrier to entry in the nascent space transportation market**
  - **Accept the risk of capabilities not materializing**
    - Backup options would revert to NASA and international partner capabilities

Program Formulation (Cont.)

- **Formulation Authorization Document (FAD)**
  - *…The C3P consists of demonstration projects executed using Space Act Agreements. Additionally, NASA does not intend to take ownership of any flight or ground systems. Therefore, the C3 Program shall not be bound by Program and Project requirements defined within NPR 7120.5C. However, using NPR 7120.5C as a guide, Program Management will develop and implement processes needed to provide necessary and appropriate Program insight to ESMD, and the Agency PMC.*
- **Streamlined requirements allowed program to be staffed with a small number of personnel**
  - **Approximately 10 FTE civil service and 3 WYE support contractor (COTS cargo)**
  - **Program management and administration, and technical support <5% of total budget**
  - **ISS visiting vehicle integration costs were covered by the ISS program**

Commercial Crew & Cargo Program Office

Johnson Space Center



Program Execution

- **Commercial Partner Oversight/Insight**
  - **Oversight (Official Government Approval/Direction)**
    - NASA *oversight* was limited to assessment and approval of a series of fixed milestone payments listed in the SAA based on pre-negotiated objective success criteria
    - NASA also provided formal verification approval of ISS Interface Requirements in preparation for Certification of Flight Readiness
    - Data deliverables were limited to information needed to conduct milestone completion assessments and ISS integration
  - **Insight (Information to discern project performance status)**
    - NASA insight was accomplished through day-to-day interactions between the commercial partner and the NASA Project Executive team
    - On site Quarterly Program Reviews were held with the NASA program manager and commercial partner leadership team to review current cost, schedule, technical, and risk status
    - A COTS Advisory Team of subject matter experts from across the agency were activated on a part-time, as needed basis to conduct Technical Interchange Meetings when requested by the partner, and assist the program with milestone reviews

Program Execution

- **Internal NASA Insight**
  - **The C3PO formally reported to the NASA Exploration Systems Mission Directorate (ESMD) Associate Administrator at Quarterly Program Management Reviews along with all other ESMD programs**
    - Cost performance to plan
    - Schedule performance (assessment of commercial partner milestone completion)
    - Technical accomplishments and issues (as reported by commercial partner)
    - Program risk status
  - **Monthly reports were submitted to the agency Baseline Performance Reviews**
  - **Weekly status telecons were also conducted with the HEOMD AA**
  - **Program Technical Authorities were identified for matters related to crew health and safety**
  - **Program was favorably reviewed and audited by several organizations including the GAO, IG, ASAP, and NAC**

Summary

- **COTS proved to be a successful, cost-effective new way of doing business with commercial industry**
- **It can be a model for other programs but requires careful consideration of goals, objectives, and programmatic risk**

Backup

SpaceX COTS Summary

- COTS Space Act Agreement awarded August 2006 and amended in December 2010 with additional risk reduction milestones
- All 40 milestones completed in August 2012 for payments totaling $396M
  - Demo Mission 1: December 8, 2010
  - Demo Mission 2/3: May 22-31, 2012
- Key Facts:
  - New Falcon 9 U.S. launch vehicle
  - New autonomous Dragon cargo spacecraft capable of carrying cargo to and from the ISS and LEO
  - New commercial launch facility at CCAFS, FL

Falcon 9


ISS Capture of Dragon


Cape Canaveral Launch Site

SpaceX COTS Demonstration Launches

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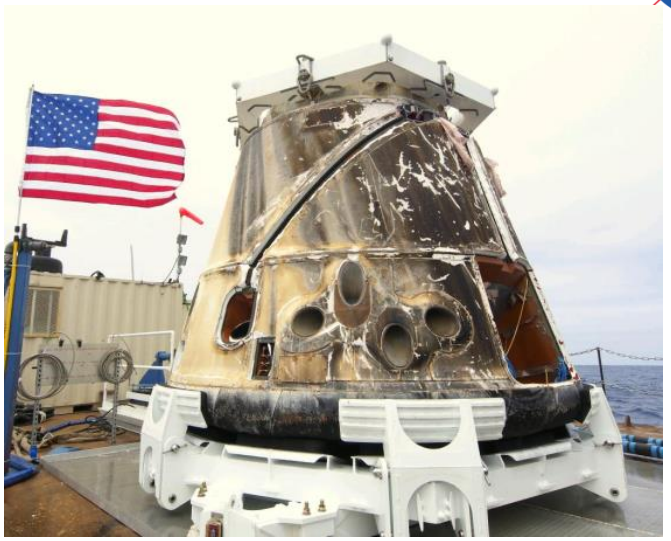
SpaceX COTS Demo Mission C2+ Cargo Return

Dragon splashdown in Pacific May 31,2012

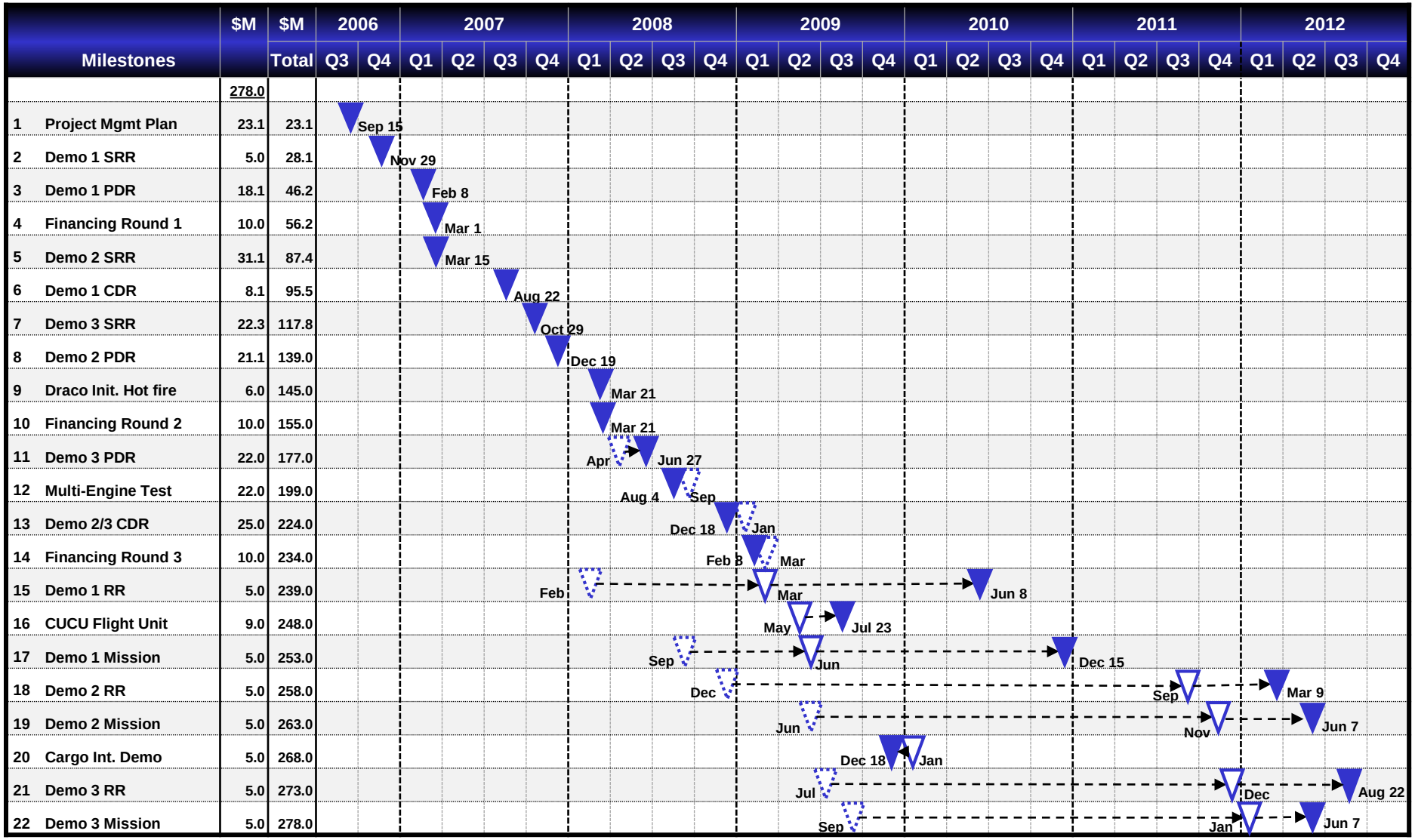


On recovery ship

Dragon in McGregor, TX

Returned ISS cargo

SpaceX COTS Milestones



Current Plan

Initial SAA Plan

Actual Completion Date

COTS COMMERCIAL ORBITAL TRANSPORTATION SERVICES

SpaceX Augmented COTS Milestones

	Milestones	$M	$M Total	2007 Q1	2007 Q2	2007 Q3	2007 Q4	2008 Q1	2008 Q2	2008 Q3	2008 Q4	2009 Q1	2009 Q2	2009 Q3	2009 Q4	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4	2012 Q1	2012 Q2	2012 Q3	2012 Q4
		118.0																								
23	Modal Test Plan	5.0	5.0																	Dec 16						
24	Modal Test	5.0	10.0																	Dec 16						
25	LIDAR Test (open loop)	5.0	15.0																	Dec 16						
26	Solar Array Deploy Test	5.0	20.0																	Dec 16						
27	LIDAR Test Plan (closed loop)	5.0	25.0																	Mar 31						
28	Thermal Vacuum Test Plan	5.0	30.0																	Mar	Apr 6					
29	Infrastructure Plan	10.0	40.0																	Mar	May 10					
30	Thermal Vacuum Test	20.0	60.0																		Jul	Sep 14				
31	Test site Infrastructure Implementation	5.0	65.0																		Jun 23					
32	Dragon Trunk Acoustic Test	10.0	75.0																		Jun 23					
33	LIDAR Test 6 DOF (closed loop)	5.0	80.0																		Aug	Oct 26				
34	Design Rev. Enhanced Powered Cargo Accom.	5.0	85.0																			Aug 24				
35	Design Rev. Pressurized Cargo Vol Increase	5.0	90.0																			Aug 24				
36	Dragon EMI/EMC Test (HITL)	10.0	100.0																		Jul	Sep 20				
37	Dragon Cargo Racks & Hatch Simulator	3.0	103.0																			Aug 26				
38	Ground Demo Enhanced Powered Cargo	5.0	108.0																			Sep	Oct 26			
39	Launch site Infrastructure Implementation	5.0	113.0																			Sep	Oct 26			
40	Production Infrastructure Implementation	5.0	118.0																			Sep	Oct 26			
	SAA Total	396.0	396.0																							

Current Plan

Actual Completion Date

Initial SAA Plan

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10-27-11

Orbital COTS Summary

- Space Act Agreement awarded February 2008 and amended in December 2010 with additional risk reduction milestones
- All 29 milestones completed in November 2013 for payments totaling $288M
  - Maiden Test Flight: April 21, 2013
  - ISS Demo Mission: Sep. 18-23, 2013
- Key Facts:
  - New Antares U.S. launch vehicle
  - New autonomous Cygnus cargo spacecraft capable of carrying cargo to the ISS and disposing cargo from the ISS
  - New commercial launch facility at Wallops Island, VA

Antares


Cygnus Approaching ISS


MARS/Wallops Launch Site

Orbital COTS Demonstration Launches

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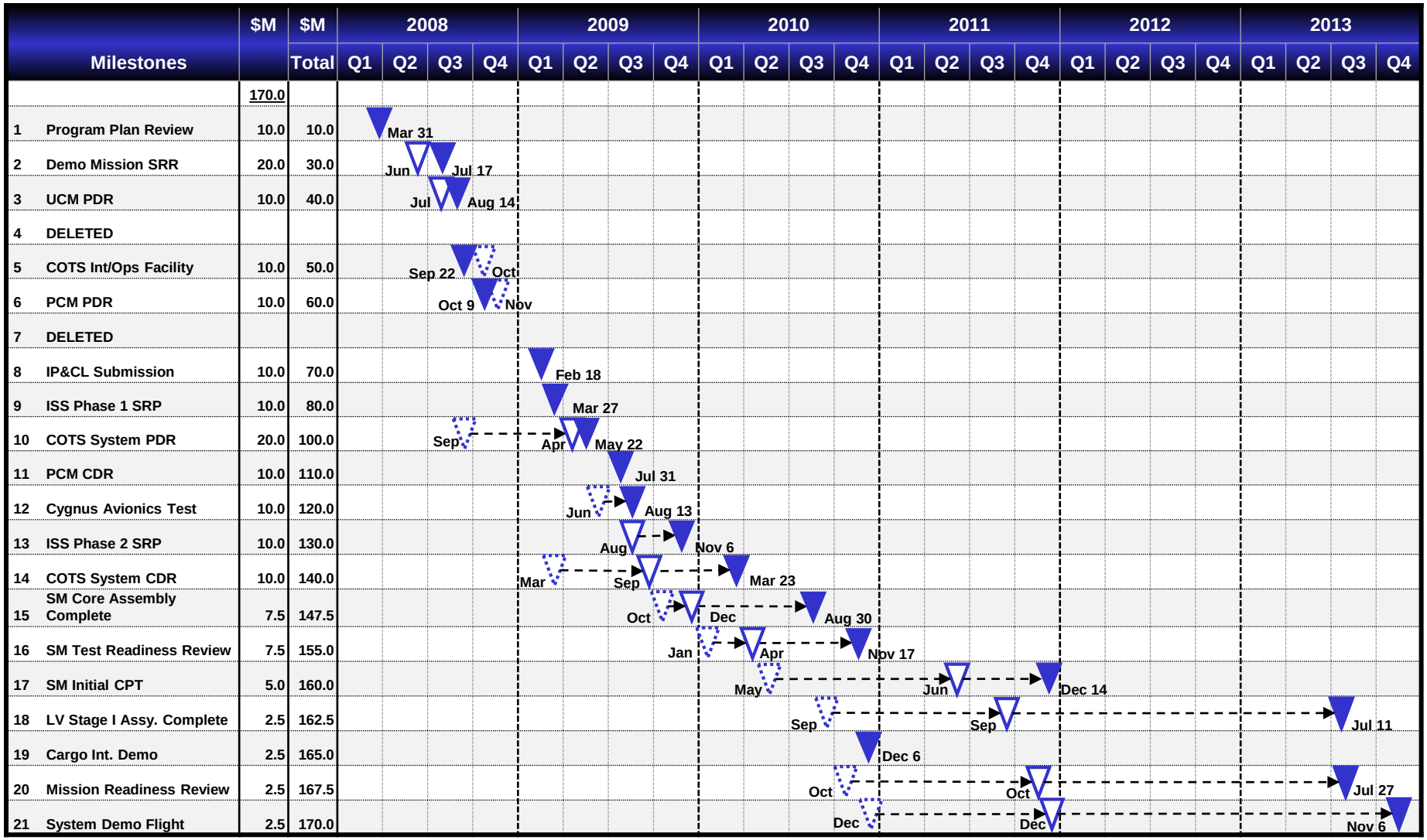
Orbital D-1 ISS Demonstration Mission

Orbital COTS Milestones



Current Plan

Initial SAA Plan

Actual Completion Date

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Orbital Augmented COTS Milestones

	Milestones	$M	$M Total	2008 Q1	2008 Q2	2008 Q3	2008 Q4	2009 Q1	2009 Q2	2009 Q3	2009 Q4	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4	2012 Q1	2012 Q2	2012 Q3	2012 Q4	2013 Q1	2013 Q2	2013 Q3	2013 Q4
		118.0																								
22	Test Flight Mission Review	20.0	20.0													Dec 15										
23	Test Flight Mission Analys.	10.0	30.0														Feb 23									
24	Cygnus Mass Sim. (CMS) Design Review	10.0	40.0															Mar 03								
25	Install Add'l PITL Simulators	5.0	45.0													Apr		May 6								
26	PROX FEU Test Unit	5.0	50.0														May		Jun 17							
27	Maiden Flt Stg 1 Core Del.	24.0	74.0															Apr 28								
28	Maiden Flt Uppr Stage Del.	20.0	94.0																Jun 21							
29	Maiden Flt CMS Delivered	10.0	104.0																Jun 20							
30	Maiden Flt Stage 1 Assy.	10.0	114.0																Jul			Sep 17				
31	Maiden Test Flight	4.0	118.0																Oct					May 9		
	SAA Total	288.0	280.5																							

Current Plan

Actual Completion Date

Initial SAA Plan

COTS COMMERCIAL ORBITAL TRANSPORTATION SERVICES